
Space Weather Technical Forecast

Issued on Monday, 09 May 2022 at 01:10 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Chance of G1 later UTC day of Tuesday. Chance of R1/R2 radio blackouts.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low through the UTC day of Sunday 08 May, with isolated C-class flares recorded at GOES16. The largest of these flares was a C8.2 at 08/1938UTC from a new region arriving over the southeastern limb, currently designated AR3007 but with the general area perhaps forming more than one sunspot group. This event appeared to produce ejecta in two stages, and although this has yet to be analysed, any Earth-bound component is very unlikely, as is any solar radiation storm affecting Earth.



Figure 0: HMIB and AIA193 composite image (courtesy of Helioviewer.org) of aftermath of the C8.2 flare and southeast limb CME (shown) from the vicinity of arriving sunspot group(s) AR3007. Also shown is AR3006 on the right – the delta spot is near the centre of this group with a bright white set of pixels in the upper left of a larger black region.

There are currently five numbered sunspot regions on the facing side of the sun. The two dominant sunspots of last working week (delivering many M-class flares at that time) now appear generally in decline, with AR3004 showing fading of its trailing spots and Mt Wilson delta to leave a Dho/Beta group by the period's end. AR3006, to the east was more complex, although its spot generation largely ceased, taking up instead a spreading tendency. Its delta was however maintained in the leading group, with its class therefore a small Dai/Beta-Delta.

By contrast, in the ascendancy was the southeastern limb spot(s), the westernmost portion of which at least has been accorded the number AR3007, and is either a Chi in its own right, with a possible Dki and Bxo following to its east, or if the whole area proves to be magnetically interconnected, then it may constitute an Fki/Beta at least.

In terms of other spots, AR3001 remained stable and unchanging as an Hsx/Alpha near the western limb, with a northern hemisphere bipolar group, AR3005 seeing its previous rapid growth stall at Csi/Beta.

The solar 'tropics' remain congested with long chains of filaments at present. Of note was a northeast quadrant dimming and filament arcade from around 08/0200UTC, roughly coincident with a southeast limb Coronal Mass Ejection (CME). Any filament CME from the 08/0200UTC event is extremely faint and has not been analysable to date, however Lasco C2 imagery does suggest that possible faint ejecta is mainly above and behind Earth in the track of its orbit. A third possible filament-related event occurred just after 08/1200UTC in the northwest near the limb, with a narrow CME subsequently seen heading well west in coronagraphs. A final event (the possible CME pair) was from the southeastern limb C8.2 flare, with no Earth-bound component anticipated, although analysis is pending.

All considered, no CMEs were confirmed in available satellite imagery in the past 24 hours.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR and ACE at L1, followed a slow regime, with the speed showing a gradual rise and fall within 300-350km/s. The solar wind density was similarly unremarkable in low single-figures ppcc. Meanwhile the IMF was a little erratic, with a peak of 9nT, and an north-south range of +2/-4nT, again mostly anti-aligned (with Earth's field). The phi angle was mostly negative (towards the Sun), albeit with a brief foray into positive around 08/1300UTC, which was concurrent with the peak IMF. Resulting geomagnetic activity was mainly Quiet, but with a provisional peak Kp of 3- recorded in the 09-12UTC interval.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV) has been at Background levels through the last 24 hours.

The high energy electron flux has varied between Moderate and High levels, reaching a peak of 1100pfu at 08/1610UTC. Electron fluence showed a slight decline, with the 24-hour integrated observed value at 09/0001UTC being 2.7e7pfu.

Four-Day Space Weather Forecast Summary

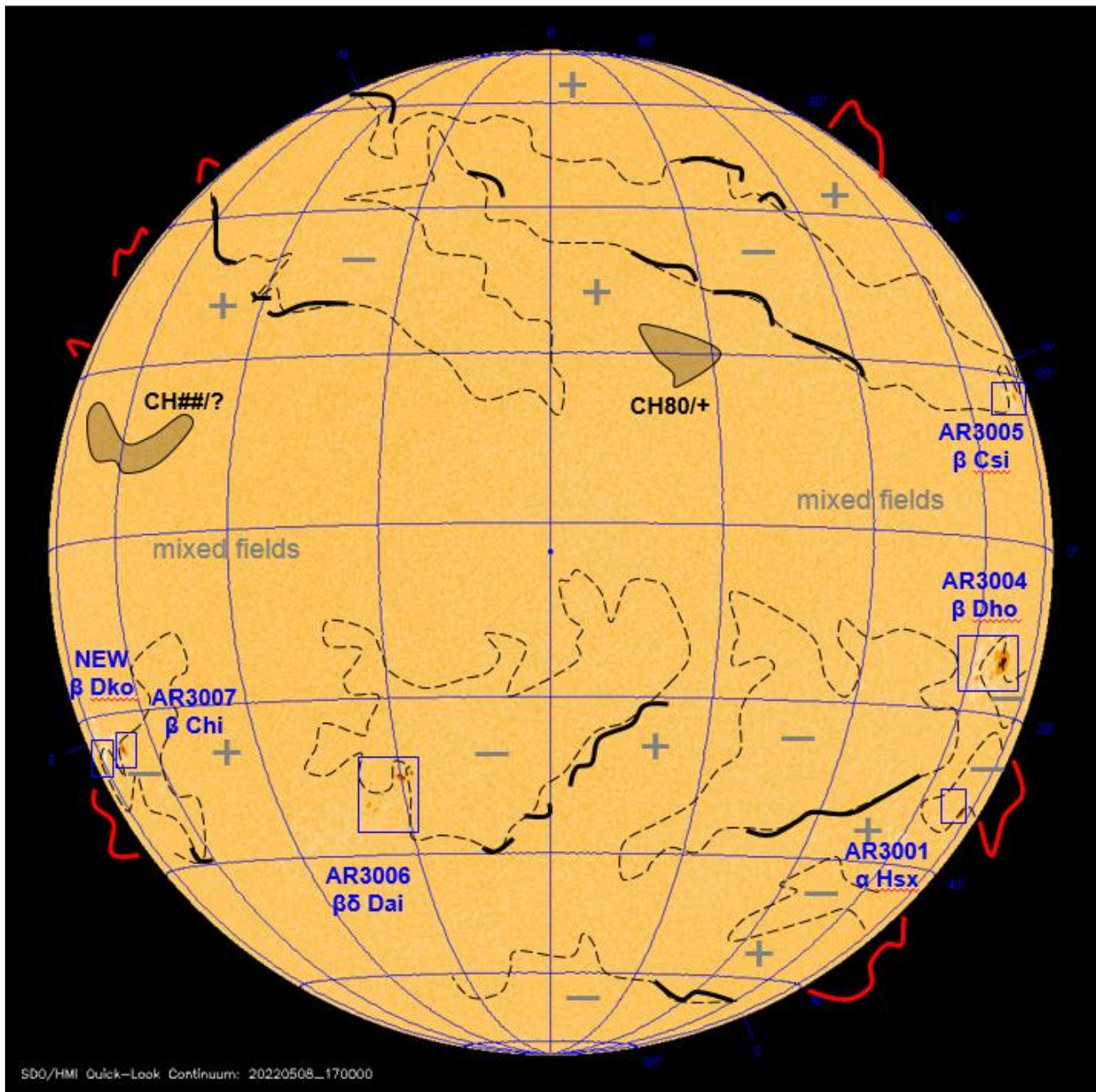
Solar Activity: Solar activity is likely to be Low to Moderate, as although some of the more potent recent spots are quietening down and/or rotating off the disc, newly-arrived active regions in the southeast are bolstering the risk to a degree.

Solar Wind / Geomagnetic Activity: A CME spawned by a disappearing filament 06/1900UTC may give Minor Geomagnetic Storm G1 intervals later Tuesday 10 May and on into Wednesday (UTC days). No significant coronal holes feature in this forecast - in any case, the sole small feature CH80/+ will likely be coincident with the aforementioned CME and its effect therefore masked. Geomagnetic activity should otherwise be Quiet to start and end the four-day period in the prevailing slow solar wind regime, probably most reliably so on Monday 09 May.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) is at Background levels, with a daily Slight Chance of S1 largely as a result of AR3004's position near the western limb.

The high energy electron flux (greater than 2MeV) is forecast to remain at predominantly Moderate levels, but could reach the High threshold (1000 pfu) at the peak of its diurnal oscillation. A decline in the flux is expected through the four days, especially if geomagnetic activity increases with the 06/1900UTC CME arrival. 24-hour fluence is now Expected to remain below the Active threshold.

Figure 1. Solar Analysis Valid 08/1700UTC.



Key: Filament — , Prominence — , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

The CME from 03/1700UTC has been dropped from the forecast, leaving one CME en route from a northeastern quadrant filament lift off that occurred 06/1900UTC.

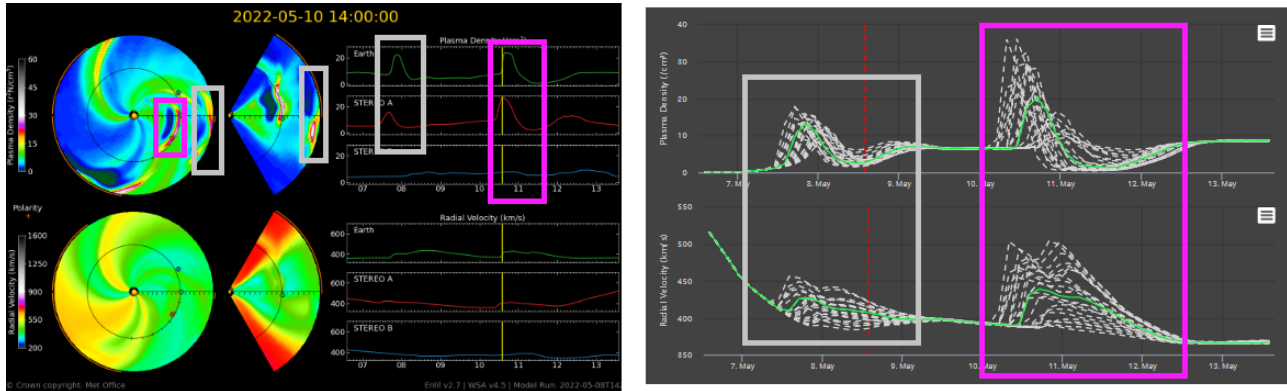
There is one small non-persistent coronal hole on the disc at present that features in the forecast, CH80/+ in the northern solar hemisphere. Any Earth-based effect is likely to be around midweek UTC, however the impact is likely to be minimal, probably proving indistinct due to the anticipated CME arrival. MOSWOC Enlil currently assesses this feature as having an arrival time around mid-afternoon UTC on Tuesday 10 May, with effects then probably continuing into Wednesday 11 May. Slightly lowering confidence in this onset is the fact that MOSWOC Enlil has a quicker than expected intervening solar wind, with an enhancement from a persistent coronal hole that no longer exists. This means that the transit time to 1AU for the impending CME ought to be slower than suggested, and the risk of G1 is therefore roughly equally partitioned between Tuesday and Wednesday.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	1	30	20	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
07/0700	Partial	Filament	NE Quadrant	581km/s	After 10/1500UTC	Probable arrival marginally later than Enlil suggests

Figure 2: MOSWOC Enlil and ensemble, showing the 03/1700UTC CME (now thought to have missed Earth, grey box) and the 06/1900UTC CME in magenta. As stated, effects from this CME may be slightly delayed relative to model thoughts due to the observed lack of the intervening high speed stream which Enlil is suggesting. The risk of G1 is therefore partitioned more equally between the UTC days of Tuesday and Wednesday.



Radio Blackouts - X-Ray Flares:

There are now five numbered sunspot regions on the solar disc. The UTC weekend has seen the focus of solar activity swing away from previously dominant AR3006 and 3004, shifting instead to the developing southeast limb. At present there is at least one sunspot region here, currently with the westernmost portion numbered AR3007, but possibly followed by another large group to its immediate east and perhaps a small bipolar group to its northeast. The precise Zurich and Mt Wilson classification of this part of the sun is therefore open to question at present, as further rotation may yet reveal minor spots within the containing plage(s).

The balance of front-side groups should be in a state of flux during the next 48 hours or so, with AR3004, AR3001 and AR3005 all due to exit stage right before midweek UTC, while the eastern limb may reveal up to two further regions in the next four days judging from STEREO A imagery. Given that any returning regions need to be confirmed before assessing their contribution to flare risk, the trend in X-ray flux should perhaps be slightly downwards overall, although AR3004 is now a shadow of its former self and has not contributed significant flares to the daily roster for some time. Activity in the period should therefore mainly emanate from both the southeastern groups, and perhaps AR3006, which although simpler, does still retain a Mt Wilson delta and carries the potential to re-develop.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	40	40	30	30
Very Active	R3 to R5 X Class	No	5	5	5	5

Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as measured by GOES-16 at GEO is at Background levels, and is most likely to remain so through the next four days.

There is a daily Slight Chance of S1, mainly due to AR3004's approach towards the western limb but also now AR3005. Despite this slight risk, it should be noted that none of the current disc have a history of producing any proton response at GOES16.

Radiation Storms	Level (cm ⁻² sr ⁻¹ s ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	2	5	5	2
Very Active	≥ S3*	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = cm⁻²sr⁻¹s⁻¹)

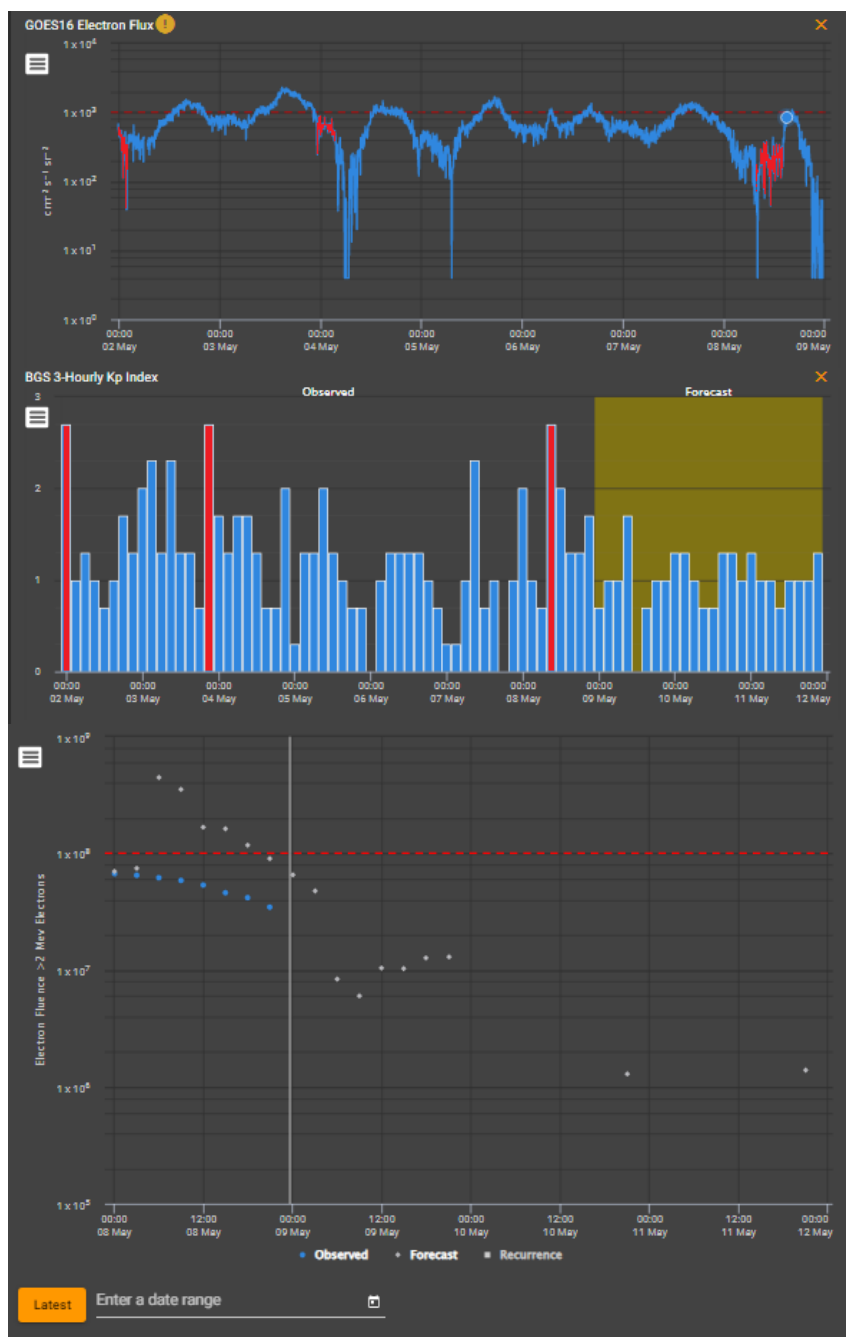
High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2MeV) is forecast to be mainly Moderate, perhaps reaching High levels in its diurnal oscillation. A gradual decline in fluence is otherwise likely through the period in the unsupportive current solar wind environment.

The likelihood for Active fluence levels to be reached should reduce with time, especially with potential significant geomagnetic activity occurring in the wake of any CMEs. Output from MOSWOC REFM is therefore considered to be offering good guidance in keeping the fluence below the Active threshold, combined with a declining trend.

GEO Electron Environment	Level (cm ⁻² sr ⁻¹ day ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1x10 ⁸	No	5	5	5	5
Very Active	≥ 2 MeV ≥ 1x10 ⁹	No	1	1	1	1

Figure 3: Past week in high energy electrons at GOES16 and BGS 3-hourly Kp indices, showing roughly concurrent decreases in flux with Unsettled geomagnetic activity (red portions of graphs). Also shown is the latest MOSWOC REFM.



NOTE: Our REFM model has been upgraded and has changed in appearance. The two main changes are the option to include a recurrence graph (not shown on the above plot), which superimposes observations from the last solar rotation onto the current solar rotation (each plot is the observation from T-minus 28 days). Recurrence is used as a guide to what can be expected in the coming days assuming no difference in solar features, and has low accuracy in certain situations but good accuracy in others (such as recurring coronal holes). The other change is the cadence of REFM forecast fluence data has been reduced past day 1 to only one value per day. The cadence remains 3-hourly for the first 24 hours.